Norio SAHASHI*: **Spore morphology of the Japanese species of the Botrychiaceae**

佐橋紀男*: 邦産ハナワラビ科の胞子の形態

(Plates VII—XI)

Botrychiaceae Nishida is represented in Japan by three genera which consist of the following ten species.

1. *Botrychium lanceolatum* (Gmel.) Angstr.
2. *B. lunaria* (L.) Sw.
3. *B. simplex* Hitch. var. *tenebrosum* (Eat.) Clausen
4. *Japanobotrychium strictum* (Und.) Nishida
5. *J. virginianum* (L.) Nishida
6. *Sceptridium* (§ Sceptridium) *daucifolium* (Wall.) Lyon
7. *S.* (§ S.) *japonicum* (Prantl) Lyon
8. *S.* (§ Multifida) *minus* (Hara) Nishida
9. *S.* (§ M.) *multifidum* (Gmel.) Nishida
    a. var. *multifidum*
    b. var. *robustum* (Rupr.) Nishida
10. *S.* (§ M.) *ternatum* (Thunb.) Lyon
    a. var. *ternatum*
    b. var. *nipponicum* (Makino) Nishida

The author observed morphologically the spores of all species listed above by the light microscope (LM). He also tried to compare the spore ornamentations by the scanning electron microscope (SEM) except for one species. Comparing the results of both by LM and SEM observations, the author will discuss the spore ornamentations and taxonomical survey of the genera in the Botrychiaceae.

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Materials and methods The spores of about 100 samples were observed in this study. Most samples were collected in the field while some other samples were obtained from specimens in the herbaria of the following institutions: CHIB*: Herbarium, Chiba University. KYO: Department of Botany, Faculty of Science, Kyoto University. MAK: Makino Herbarium, Tokyo Metropolitan University. TI: Botanical Institute, Faculty of Science, Tokyo University. TOFO: Institute of Forest Botany, Faculty of Agriculture, Tokyo Univeresity. TOHO: Toho University. TNS: Department of Botany, the National Science Museum, Tokyo. The author carefully selected only mature and uncontaminated samples.

In preparation for LM study, the author followed Ikuse's method (1956). Namely, materials were fixed with absolute alcohol on slide glass. After stained with 0.01% alcoholic solution of gentian violet, materials were directly mounted in glycerine jelly and sealed with cover glass and paraffin. On the other hand, SEM samples were put on the specimen stub covered with the appropriate mountant (Do-tite) and coated with a thin layer of carbon followed by gold metal. Specimens were examined using the JSM-U3 scanning electron microscope, normally working at 15kv. The measurement of the spores indicates the longest axis when only one measurement is given. In the trilete spore, polar diameter × equatorial diameter is indicated as P × E, and the projections are not included here. At least 30 grains of each species were measured at the magnification of 600 or 1000 times.

The descriptive terms are used following those of Erdtman (1952), Harris (1955) and Kawasaki (1973). The technical terms and abbreviations defined by the author are as follows.

Alete: Devoid of apertures.

Amb (Ambitus): Outline of spore or pollen grain viewed from the exact top of one pole.

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* This abbreviation is not yet registered internationally.

DF: Distal face.

Distal face: The face of a spore opposite to the dehiscence surface.

DP: Distal part.

Extervermiculate: With irreuglar and sometimes branched projections.

Foveolate: With broad irregular depressions or pits whose diameter is longer than 1 μ.

GL: Globoid.

Laesura: Somewhat colpus-like aperture in mono- and trilete spores.

PF: Proximal face.

Proximal face: The surface of a spore including the aperture.

PP: Proximal part.

Reticulum: Sculptured pattern consisting of a network of well-defined ridges (muri) which encompass regular or irregular areas (lumina).

RT: Rounded triangle.

ST: Subtriangle.

TQ: Triquete.

Trilete: Possessing a triradiate tetrad scar.

Triquete: Trilete spores with rounded apices and concave margins.

Tuberose: With somewhat lower projections than verrucae, and more rounded.

Vallate: With rather shrot broad furrows separated by ridges or walls.

Verrucose: With low irregular wart-like projections whose basal diameters are as a rule longer than any other tangential diameters of the projections.

Results

1. *Botrychium lanceolatum* (Gmel.) Angstr.

LM study: Hokkaido, Aug. 1903; T. Makino (MAK). Nagano Pref., Aug. 1928; M. Honda (TI). Nagano Pref., Aug. 1937; M. Nakamura (CHIB). Nagano Pref., Jul. 1949; S. Hurusawa (TI). Shizuoka Pref., Sept. 1953; T. Yamazaki (TI).

Shape: Trilete. Amb ST often RT, PP convex to nearly flat, DP hemispherical often convex. Size: 29(24-37) × 35(28-41)μ. Laesura: 8-20μ long, with a little prominent ridge up to 3 μ tall at the pole. Exine: Light-yellow, semitransparent, c. 2 μ thick, DF densely tuberose or with irregular verruca-like projections, c. 2μ high, 2-5μ in diameter, PF with small verruca-like processes, contact area punctate or subpsilate.

SEM study: Shizuoka Pref., Sept. 1953; T. Yamazaki (TI).

DF: Densely tuberose often elongated extervermiculate (Pl. VII. 2), and separated by channels (often seems fossulate), surface densely covered with fine granules (Pl. X. 5).

PF: Similarly sculptured as on DF except contact area. Contact area smooth, often minutely pitted, punctate (Pl. VII. 1).

2. *B. lunaria* (L.) Sw.

LM study: Shizuoka Pref., Aug. 1916; K. Hisauchi (TOHO). Hokkaido, Jul. 1933; H. Hara (TI). Nagano Pref., Jul. 1937; M. Nakamura (CHIB). Nagano Pref., Jul. 1953; T. Yamazaki (TI). Fukushima Pref., Jun. 1968; I. Enomoto (TI).

Shape: Trilete. Amb ST or RT, often GL on TQ. PP convex to flat, DP hemispherical sometimes convex. Size: 30 (25-35) × 35 (29-41) μ. Laesura: 10-20 μ, with clear prominent ridge c. 2-3 μ tall. Exine: Light yellow, semitransparent, c. 2.5μ thick, irregularly verrucose on DF, faintly verrucose and often punctate or subpsilate on PF. Verrucae on DF c. 1-2 μ high, 2-4 μ in diameter.

SEM study: Nagano Pref., Jul. 1953; T. Yamazaki (TI).

DF: Irregular verrucae which observed by LM are not typical ones (Pl. VII. 4). Their prominently anastomosing and undulated ridges seem very close to extervermiculate ornamentation. All over the surface of spore finely granulate.

PF: Finely punctate (Pl. VII. 3), and somewhat undulated with small ridges which look like as in *B. lanceolatum*.

3. *B. simplex* Hitch. var. *tenebrosum* (Eat.) Clausen

LM study: Nagano Pref., Aug. 1922; T. Sato (MAK).

Shape: Trilete. Amb RT to ST, PP convex to flat, DP hemispherical. Size: 28(26-30) × 33(31-35)μ. Laesura: c. 15 μ long, with a little thick ridge up to 3 μ tall. Exine: Light-yellow, semitransparent, c. 2 μ thick, with partially irregular verrucae up to 1.5 μ high, 2-4 μ in diameter on DF, and almost subpsilate on PF.

This spore sample was so poor, that the author could not investigate by SEM. But as far as examined under LM study, the spore of this species is very similar in pattern to that of *B. lunaria*.

4. *Japanobotrychium strictum* (Und.) Nishida

LM study: Chiba Pref., Aug. 1951; S. Kurata (TOFO). Hokkaido, Aug. 1957; M. Nishida (CHIB). Shikoku, Aug. 1962; T. Miyauchi (TOFO). Shizuoka Pref., → Cult., Chiba Pref., Oct. 1969; N. Sahashi (TOHO). Gifu Pref., → Cult., Chiba Pref., Aug. 1970; N. Sahashi (TOHO).

Shape: Trilete. Amb RT to often GL, PP convex to flat, DP hemispherical to convex. Size: 25(22-30) × 29(25-32) μ. Laesura: 10-17 μ long, with slender ridge up to 2.5 μ tall at the pole. Exine: Light-yellow, semitransparent, c. 2 μ thick, DF with irregular verruca-like processes, 1-2 μ high, 2-6 μ in diameter, PF nearly subpsilate or scabrate. The spore is often scattered with fine granules over the whole surface.

SEM study: Shizuoka Pref., → Cult., Chiba Pref., Oct. 1969; N. Sahashi (TOHO).

DF: Large verruca-like processes from the side view (Pl. VII. 6) often coalescing into extervermiculate pattern, and do not seem to be quite compact. Some irregular wart-like projections are scattered very sparsely.

PF: Verrucae are smaller with obscure projections than on DF (Pl. VII. 5), and beset with faintly rough processes. Laesura arms are without prominent ridges.

5. *J. virginianum* (L.) Nishida

LM study: Hokkaido, Aug. 1957; M. Nishida (CHIB). Kyushu, May 1959; T. Yamazaki (TI). Tokyo, Oct. 1966; T. Ichikawa (TI). Shizuoka Pref., Jun. 1968; N. Sahashi (TOHO). Chiba Pref., Jun. 1969; N. Sahashi (TOHO).

Shape: Trilete. Amb RT to GL, PP convex to flat, DP hemispherical to somewhat convex. Size: 23.5(18-29) × 28(23-33) μ. Laesura: 8-15 μ long, with slender ridge up to 2.5 μ tall at the proximal pole and obscured towards the tips. Exine: Light-yellow, semitransparent, c. 2.5 μ thick, with large irregular verrucae 1-3 μ high, 2-6 μ in diameter on DF, and those on PF quite similar as on DF, but rather smaller.

SEM study: Tokyo, Oct. 1966; T. Ichikawa (TI).

DF: Verrucae are distinctly recognized and more densely spaced than in *J. strictum*, and often anastomosing. These verrucae seem extervermiculate, and heavily undulated at the side view (Pl. VIII. 2).

PF: Nearly equal pattern to that of DF (Pl. VIII. 1), but the shape of verrucae are more irregular in size and not so heavily waved as distal ones.

Granules are more deusely scattered all over the surface of spore (Pl. X. 6) than those of *J. strictum*.

6. *Sceptridium* (§ Sceptridium) *daucifolium* (Wall.) Lyon

LM study: Kyushu, Isl. Yakushima, Jan. 1937; H. Ito (TI). Kyushu, Isl. Amamiohshima, Apr. 1937; S. Sonohara (KYO). Kyushu, Isl. Yakushima, Jan. 1969; M. Kawabata (TOFO). Kyushu, Isl. Tokunoshima, Dec. 1972; R. Yoroi (TNS). Kyushu, Isl. Yakushima, Jan. 1975; N. Sahashi (TOHO). Shape: Trilete. Amb RT, PP convex to flat, DP hemispherical to convex. Size: 20(16-25) × 23(20-26)μ. Laesura: 8-12μ long, with somewhat slender ridge c. 2 μ tall. Exine: Light-yellow, semitransparent, c. 1.5 μ thick, densely covered with irregular papillae c. 2 μ high, 0.5-1 μ in diameter, often these papillae making a reticulum-like pattern with lumina up to 4 μ in diameter on DF; almost the same pattern on PF, but with smaller papillae and not makeing a reticulum.

SEM study: Kyushu, Isl. Yakushima, Jan. 1969; M. Kawabata (TOFO).

DF: Papillae which look like spinules or bacula by LM are seen as irregular in shape and of some complex structures (Pl. VIII. 4). At high magnification (Pl. XI. 1) these papillae are recognized to be round projections on which small graunles are densely scattered. The same granules cover the remainder of the spore surface as well. Very often these irregular papillae anastomose to form a reticulum-like prttern.

PF: Ornamantation is almost equal to that of DF (Pl. VIII. 3), but usually smaller and not reticulum-like in pattern. Laesura arms are seen very clearly with prominent Y-shaped ridge and contact area is divided almost equally into three faces.

7. *S.* (§ Sceptridium) *japonicum* (Prantl) Lyon

LM study: Wakayama Pref., Oct. 1930; H. Ito (TI). Niigata Pref., Sept. 1961; Y. Nakamura (TOFO). Shizuoka Pref., Mar. 1971; N. Sahashi (TOHO). Tokyo, Isl. Ohshima, Dec. 1974; N. Sahashi (TOHO).

Shape: Trilete. Amb RT, PP convex to flat, DP hemispherical to convex. Size: 25(22-31) × 30(24-36)μ. Laesura: 10-16 μ long, with rather prominent ridge c. 2.5 μ tall. Exine: Light-yellow, semitransparent, c. 1.5-2 μ thick, DF with irregular papillae or spinule-like projections as in *S. daucifolium*, 1.5-2.5 μ high, 0.5-1.5 μ in diameter at the base. Papillae are formed in more or less interrupted ridges that join to form a reticulum-like pattern, PF with nearly the same pattern as on DF, but papilae are smaller and usually reticulum-like pattern cannot be observed.

SEM study: Shizuoka Pref., Mar. 1971; N. Sahashi (TOHO).

DF: Ornamentation is almost the same as shown in *S. daucifolium* (Pl. VIII. 6), but this species has usually larger papillae or spinules, and generally forming a larger reticulum-like pattern.

PF: Similar ornamentation as on DF, but smaller (Pl. VIII. 5). Laesura arms appear to be somewhat thick ridges forming Y-mark.

8. *S.* (§ Multifida) *minus* (Hara) Nishida

LM study: Nagano Pref., Sept. 1932; H. Koidzumi (TNS). Nagano Pref., Oct. 1932; H. Hara (TI). Kanagawa Pref., Oct. 1932; M. Kishida (TNS).

Shape: Trilete. Amb ST, PP convex to flat, DP hemispherical to convex. Size: 24.5(22-27) × 28(25-30)μ. Laesura: 10-16μ long, with slender ridge up to 2.5μ tall. Exine: Light-yellow, semitransparent, c. 1.5μ thick, DF with reticulum-like pattern, lumina up to 1.5μ in diameter and almost equally broad muri, PF faintly foveolate-fossulate, but mainly with vallate sculptures.

SEM study: Nagano Pref., Oct. 1932; H. Hara (TI). Kanagawa, Pref., Oct. 1932; M. Kishida (TNS).

DF: Muri with more or less undulated ridges (Pl. IX. 2), lumina somewhat deep and seem to be strongly foveolate (Pl. XI. 2), surface is ornamented with very small granules.

PF: Ornamentation is rather vallate than foveolate-fossulate (Pl. IX. 1), murus-like ridges are seen near the equatorial area.

9-a. *S.* (§ Multifida) *multifidum* (Gmel.) Nishida var. *multifidum*

LM study: Nara Pref., Nov. 1952; M. Tagawa (CHIB). Niigata Pref., Sept. 1955; S. Iwano (CHIB). Fukui Pref., Oct. 1967; S. Watanabe (TOFO). Hokkaido, Sept. 1968; M. Togashi (TI). Nagano Pref., Oct. 1968; S. Kurata (TOFO).

Shape: Trilete. Amb ST to TQ, PP convex to nearly flat, DP hemispherical to convex. Size: 23.5(20-26) × 28(24-33)μ. Laesura: 10-15μ long, with slender ridge, c. 2.5μ tall. Exine: Light-yellow, semitransparent, c. 1.5μ thick, on DF more or less uniformly reticulate, with lumina up to 2.5μ in diameter and equally broad muri. PF with finely vallate or pitted sculptures.

SEM study: Hokkaido, Sept. 1968; M. Togashi (TI). Nagano Pref., Oct.

1968; S. Kurata (TOFO).

DF: Reticulae seem to be more remarkable than those of S. *ternatum* var. *ternatum* (Pl. IX. 4), lumina seem clear and somewhat regular. At high magnification (Pl. XI. 3) fine granules scattered all over the surface and concentrated on the muri.

PF: Contact area faintly vallate or foveolate (Pl. IX. 3), and with fine reticulum-like patterns near equatorial area. Areas around laesura flat or with obscure granules.

9-b. *S.* (§ Multifida) *multifidum* (Gmel.) Nishida var. *robustum* (Rupr.) Nishida

LM study: Hokkaido, Aug. 1957; M. Nishida (CHIB). Nagano Pref., Sept. 1969; S. Serizawa (Herb. Serizawa). Niigata Pref., Sept. 1971; S. Serizawa (Herb. Serizawa). Fukushima Pref., → Cult., Chiba Pref., Oct. 1972; N. Sahashi (TOHO). Mie Pref., Nov. 1973; N. Sahashi (TOHO).

Shape: Trilete. Amb ST to TQ, PP convex to nearly flat, DP hemispherical to convex. Size: 23(20-27) × 27(23-31)μ. Laesura: 8-15 μ long, with slender ridge up to 2.5 μ tall at the proximal pole. Exine: Light-yellow, semitransparent, c. 1.5 μ thick, provided with reticulum-like pattern up to 2 μ in diameter of lumina, 1-1.5 μ broad muri on DF. Contact area on PF somewhat vallate and foveolate-fossulate.

SEM study: Hokkaido, Aug. 1957; M. Nishida (CHIB). Niigata Pref., Sept. 1971; S. Serizawa (Herb. Serizawa). Fukushima Pref., → Cult., Chiba Pref., Oct. 1972; N. Sahashi (TOHO).

DF: Ornamentations quite similar to those of *S. multifidum* var. *multifidum* (Pl. IX. 6). Often shape of lumina seem to be deep and narrow grooves (Pl. XI. 4), and also very similar fine granules concentrated on the muri as shown in the preceding species.

PF: Contact area more or less finely vallate or faintly fossulate. Near the equatorial area a reticulum-like pattern finer than that of DF is observed.

10-a. *S.* (§ Multifida) *ternatum* (Thunb.) Lyon var. *ternatum*

LM study: Shizuoka Pref., Oct. 1948; S. Kurata (TOFO). Mie Pref., Nov. 1969; N. Sahashi (TOHO). Chiba Pref., Oct. 1972; N. Sahashi (TOHO). Tokyo, Isl. Aogashima, Nov. 1972; T. Yasui (TOFO). Shikoku, → Cult., Chiba Pref., Dec. 1974; N. Sahashi (TOHO).

Shape: Trilete. Amb ST to slightly TQ, PP convex to flat, DP hemispherical to convex. Size: 24.5(19-29) × 29(23-36)μ. Laesura: 9-18 μ long, with slender ridge up to 2.5 μ tall at the pole. Exine: Light-yellow, semitransparent, reticulum-like pattern up to 2 μ in diameter of lumina and with 0.5-1.5 μ broad muri on DF. Contact area of PF finely vallate or foveolate. General surface of exine shows minute granules.

SEM study: Mie Pref., Nov. 1969; N. Sahashi (TOHO). Chiba Pref., Oct. 1972; N. Sahashi (TOHO).

DF: Reticulae somewhat irregular both in size and shape of lumina and muri (Pl. X. 2). Muri develop irregularly and do not form uniform lumina. Often lumina seem strongly fossulate. At high magnification (Pl. XI. 5) both the base of lumina and muri are densely verrucose or granulate.

PF: With smaller reticulum-like pattern than on DF except contact area recognized to be flat. Contact area shows irregularly vallate or foveolate-fossulate sculptures.

10-b. *S.* (§ Multifida) *ternatum* (Thunb.) Lyon var. *nipponicum* (Makino) Nishida

LM study: Tokyo, Jan. 1915; T. Makino (MAK). Okayama Pref., Sept. 1952; M. Tagawa (CHIB). Chiba Pref., Oct. 1958; M. Nishida (CHIB). Saitama Pref., → Cult., Chiba Pref., Oct. 1974; N. Sahashi (TOHO). Nagano Pref., → Cult., Chiba Pref., Oct. 1975; N. Sahashi (TOHO).

Shape: Trilete. Amb ST to often RT or TQ, PP convex to flat, DP hemispherical to convex. Size: 24(19-29) × 27.5(23-34) μ. Laesura: 9-15 μ long, with slender ridge up to 2.5 μ tall at the pole. Exine: Light-yellow, semitransparent, c, 2 μ thick, DF with irregular reticulum-like processes up to 2 μ in diameter, and equally broad muri, and on PF somewhat vallate or foveolate ornamentations especially on the contact area. General surface of exine finely granular.

SEM study: Chiba Pref., Oct. 1958: M. Nishida (CHIB).

DF: Ornamentation very similar to that of *S. ternatum* var. *ternatum* (Pl. X. 4). However, muri of this spore somewhat clear and uniform, and lumina more or less shallow. Often strong foveolate sculptures are seen. Surface of exine densely covered with granules or verrucae (Pl. XI. 6).

PF: Contact area flat, and foveolate-fossulate around laesurae (Pl. X. 3). Undulated ridges are seen near the equatorial area.

Discussion Spores of *Botrychium* in the sense of Copeland (1947) had already been proved useful for taxonomy of various ranks, and several investigations have been reported (Knox, 1951; Harris, 1955; Erdtman &

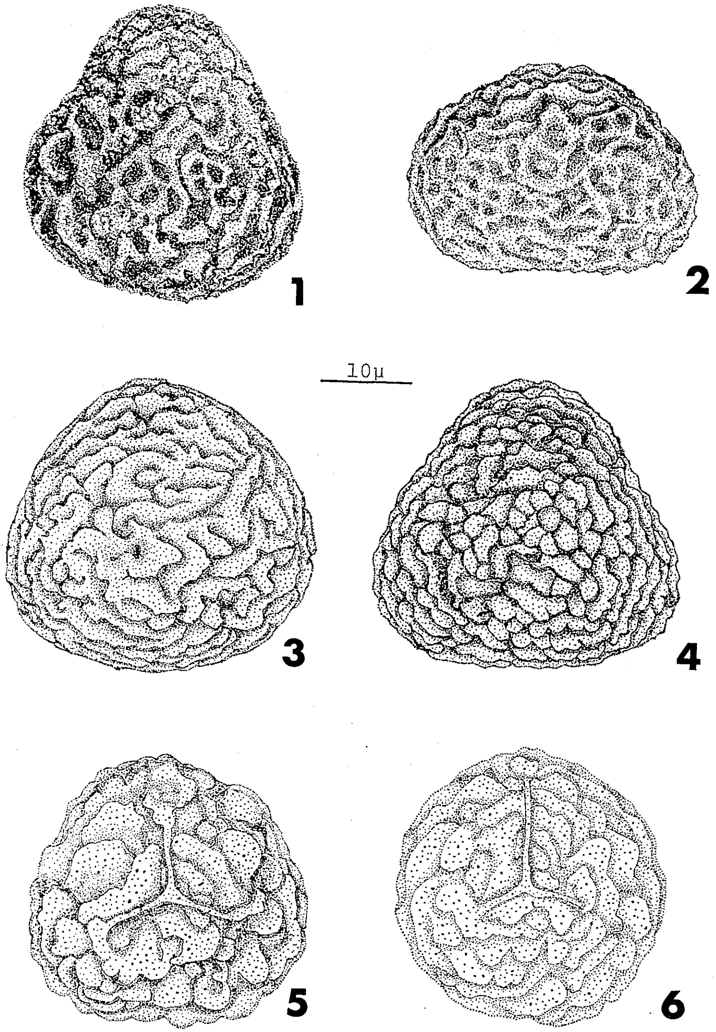
Sorsa, 1971). The previous studies, however, have been limited technically in dealing with fine structure of the spore surface.

In this study, spore morphology has been further investigated under both light and scanning electron microscopes on three genera including ten species of the Japanese Botrychiaceae Nishida (1952, 1960; cf. Tagawa, 1958). The author found that the spores of each genus have characteristic ornamentations and can be easily distinguished from each other. Furthermore, each species of these genera (except for *Sceptridium* Sect. Multifida) is also distinguishable both by size of spores and by their ornamentations. For instance, the genus *Botrychium* has typical verrucose (*B. lunaria*) and tuberose (*B. lanceolatum*) sculptures (Figs. 3, 4). While the genus *Japanobotrychium* is characterized by somewhat larger irregular verrucae (*J. strictum*) and more prominent ones (*J. virginianum*) which are scattered over the surface of spore (Figs. 5, 6).

On the other hand, the genus *Sceptridium* can be clearly divided into two groups according to the spore ornamentations. Sect. Sceptridium of the genus has peculiar spinules or papillate projections. Two species in this group are of similar pattern, but *S. daucifolium* has smaller spores than *S. japonicum*. While, Sect. Multifida is characterized by the reticulum-like pattern and fine granules densely concentrated on the muri (Figs. 1, 2). In the latter section, on the contrary, the author could not clearly divide the species from each other by the spore characters.

The spores of the same species from the different regions did not show any sharp distinction except one species, *Botrychium lunaria*. A plant of *B. lunaria* collected from Mt. Yatsugatake, Nagano Pref. in 1937 (CHIB) seems to have irregular cytological conditions. Its spores are irregular and larger than normal ones, i.e., about 30-44 × 40-70 μm, and spores of alete type are often seen in the same preparation.

The results obtained from the spore charactes in three genera of Botrychiaceae let the author support Nishida's view to keep Botrychiaceae as an independent family and to divide the genus *Sceptridium* into two sections. However, it is rather difficult to clarify the phylogenetic relationship between these three genera using the spore characters. In the meantime, the spores of the Japanese Ophioglossaceae have ornamentations more or less similar to those of Botrychiaceae (Nakamura & Shibazaki, 1959, Sahashi, 1969).



Figs. 1-6. Spores of Botrychiaceae illustrated under the light and electron microscopic observations. 1. *Sceptridium ternatum*, polar view. 2. *Sceptridium ternatum*, equatorial view (side view). 3. *Botrychium lunaria*, polar view, distal face. 4. *Botrychium lanceolatum*, polar view, distal face. 5. *Japanobotrychium virginianum*, polar view, proximal face. 6. *Japanobotrychium strictum*, polar view, proximal face.

The spores of each species in the former family have somewhat unique ornamentations of typical reticulate pattern (Nakamura & Shibasaki, Pl. I, II; Sahashi, p. 49).

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Explanation of Plates VII-XI

Plate VII. 1-2. *Botrychium lanceolatum*. 1. Polar view, proximal face. 2. Polar view, distal face. 3-4. *Botrychium lunaria*. 3. Polar view, proximal face. 4. Polar view, distal face. 5-6. *Japanobotrychium strictum*. 5. Polar view, proximal face. 6. Equatorial view (Side view).

Plate VIII. 1-2. *Japanobotrychium virginianum*. 1. Polar view, proximal face. 2. Equatorial view. 3-4. *Sceptridium daucifolium*. 3. Polar view, proximal face. 4. Equatorial view. 5-6. *Sceptridium japonicum*. 5. Polar view, proximal face. 6. Equatorial view.

Plate IX. 1-2. *Sceptridium minus*. 1. Polar view, proximal face. 2. Polar view, distal face. 3-4. *Sceptridium multifidum* var. *multifidum*. 3. Equatorial view. 4. Polar view, distal face. 5-6. *Sceptridium multifidum* var. *robustum*. 5. Polar view, proximal face. 6. Polar view, distal face.

Plate X. 1-2. *Sceptridium ternatum* var. *ternatum*. 1. Polar view, proximal face. 2. Polar view, distal face. 3-4. *Sceptridium ternatum* var. *nipponicum*. 3. Polar view, proximal face. 4. Polar view, distal face. 5. *Botrychium lanceolatum*, a part of distal face. 6. *Japanobotrychium virginianum*, a part of proximal face.

Plate XI. 1. *Sceptridium daucifolium*, a part of distal face. 2. *Sceptridium minus*, a part of distal face. 3. *Sceptridium multifidum* var. *multifidum*, a part of distal face. 4. *Sceptridium multifidum* var. *robustum*, a part of distal face. 5. *Sceptridium ternatum* var. *ternatum*, a part of distal face. 6. *Sceptridium ternatum* var. *nipponicum*, a part of distal face.

* * * *

西田 (1952, 1960), 田川 (1958) の分類システムによる邦産ハナワラビ科 (Botrychiaceae) の3属10種の胞子の形態を光学顕微鏡と走査型電子顕微鏡で詳細に観察した。その結果, Copeland (1947) らがハナヤスリ科 (Ophioglossaceae) の一属に一括している *Botrychium* 属は胞子の形態的特性からも3属に分類できることを確認した。すなわちヒメハナワラビ属 (*Botrychium*) の胞子は遠心極面においてヒメハナワラビ (*B. lunaria*) が中位の疣状紋 (verrucose) であり, ミヤマハナワラビ (*B. lanceolatum*) では密円球状突起 (tuberose) なので両者は明確に区別できる。ナツノハナワラビ属 (*Japanobotrychium*) では大きめの疣状突起が向心極面でも見られ, より突起の明確なナツノハナワラビ (*J. virginianum*) と, やゝ不明確なナガホノナツハナワラビ (*J. strictum*) に分けられる。一方オオハナワラビ属 (*Sceptridium*) は西田 (1960) が指摘したように2つの節に分けられる。すなわち Sect. Sceptridium のオオハナワラビ (*S. japonicum*) とホウライハナワラビ (*S. daucifolium*) は, 胞子の外壁のパターンが小刺状 (spinule) あるいは短突起状 (papilla) で, しかもこれらが大きな網目 (reticulum) をしばしば形成している。両者はパターンでは区別が困難であるが, 胞子の大きさにおいてホウライハナワラビの方がオオハナワラビより最大 10 μ も小さいので区別できる。しかしながら Sect. Multifida に属するフユノハナワラビ (*Sceptridium ternatum* var. *ternatum*) とアカハナワラビ (*S. ternatum* var. *nipponicum*), ヤマハナワラビ (*S. multifidum* var. *multifidum*) とエゾフユノハナワラビ (*S. multifidum* var. *robustum*), それにウスイハナワラビ (*S. minus*) は, いずれもそれらのパターンが小網状紋か, それに近い疣状, あるいは不規則なリッジを形成しており, これらは走査電顕でさえ明確な相違点を見出すことは困難であった。また採集地による同種の胞子の形態的な相違, 特に胞子表面の彫紋に関しては光学レベルでは有意の差は認められなかった。胞子の大きさについても採集地による

差は明確に捕えられなかった。しかし1937年長野県八ヶ岳で採集されたヒメハナワラビの胞子は明らかに異常であり，染色体の倍加による胞子の形態的特徴を示している。一方西田の分類になるハナヤスリ目の中のハナヤスリ科の胞子の形態については我国では中村ら（1959）と佐橋（1969）によって報告されており，その胞子の形態はハナワラビ科に似ているが胞子表面の彫紋は明らかに異なっており区別が可能である。従ってハナワラビ科とハナヤスリ科は西田（1952）の説を胞子の形態だけからでも支持できるものと思う。

○日本産スミレ属雑記（浜　栄助・中島邦雄） Eisuke HAMA & Cunio NACKEJIMA: Notes on the violets of Japan

さきに著者の1人浜は「原色日本のスミレ」誠文堂新光社（1975）を出版し，それまでに知られている日本産のスミレ属を記録し，40種，3亜種，39変種，75品種および75雑種をとりあげた。その中で，いくつかの学名を整理したが，反面，新しい名を用意し，また組み変えをおこなった。そこでこれらの事項に，中島の知見を加えて，一応整理のついたものからここにまとめて正式に発表する。但し，雑種のうち，既に命名されているものに属する新しい品種などについては，「原色日本のスミレ」に，整理の都合上便宜的に新名をのせたが，その正式発表は，繁雑になり必要もないと思われるので，ここでは扱わないことにしたい。記載に用いた基準標本は，整理のつき次第，順次主要研究機関に納める予定である。

この稿をまとめるに当り，今日まで終始懇切な指導と援助を賜った前川文夫博士，竹内亮先生および橋本保先生に深甚なる感謝の意をささげたい。

1. *Viola rostrata* Pursh var. *rostrata* form. **alpina** Hama, f. nov.

Differt a *V. rostrata*, planta minore et purpurascenti, floribus atro-purpureis. Cetera ut in typo.

Nom. Jap. Miyama-nagahashi-sumire, nov.

Hab. Along sunny footpath on ridge of subalpine zone of Central Hondo at alt. 1,300-1,600 m; Mt. Happo-dake, Prov. Shinano. (E. Hama, Jul. 26, 1962—typus in Herb. E. Hama.).

2. *Viola ovato-oblonga* (Makino) Makino form. **variegata** Hama, f. nov.

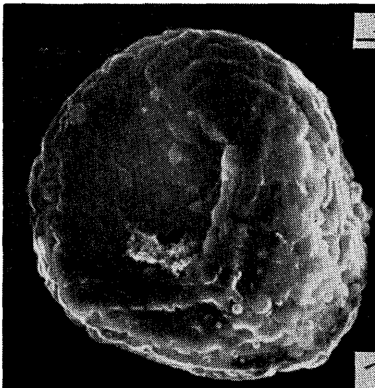
Folia viridia sed venae rubro-purpurascentes. Cetera ut in typo.

Nom. Jap. Madara-nagabano-tachitsubo-sumire, nov.

Hab. Kyushu: Yūin-machi, Ōita-gun, Prov. Bungo. (E. Hama, Apr. 28, 1963—typus in Herb. Hama.).

3. *Viola mirabilis* Linn. var. *subglabra* Ledebour form. **Seiichii** Hama, f. nov.

Differt a *V. mirabili* var. *subglabra*, floribus albis. Cetera ut in typo.



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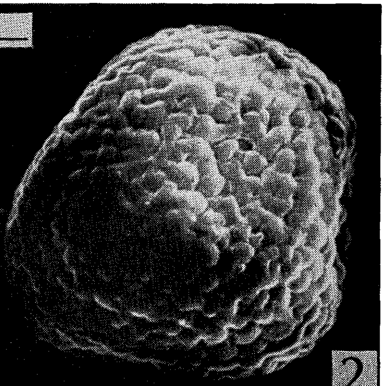

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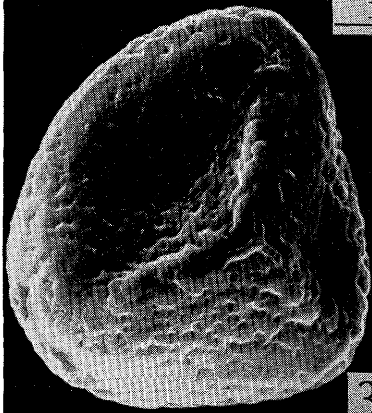

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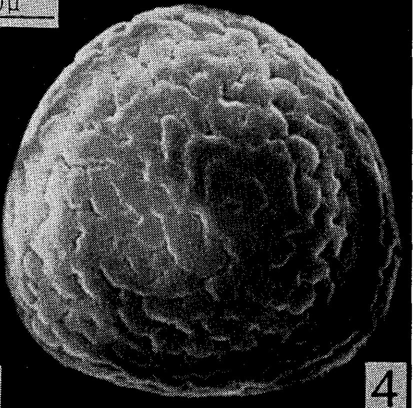

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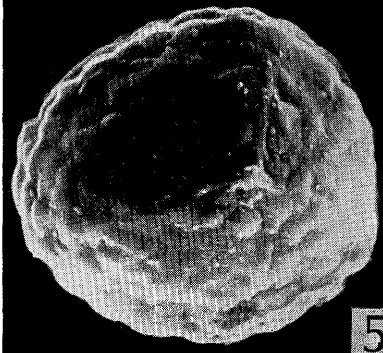

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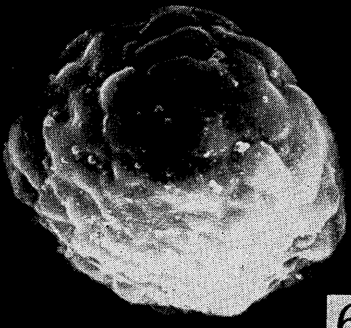

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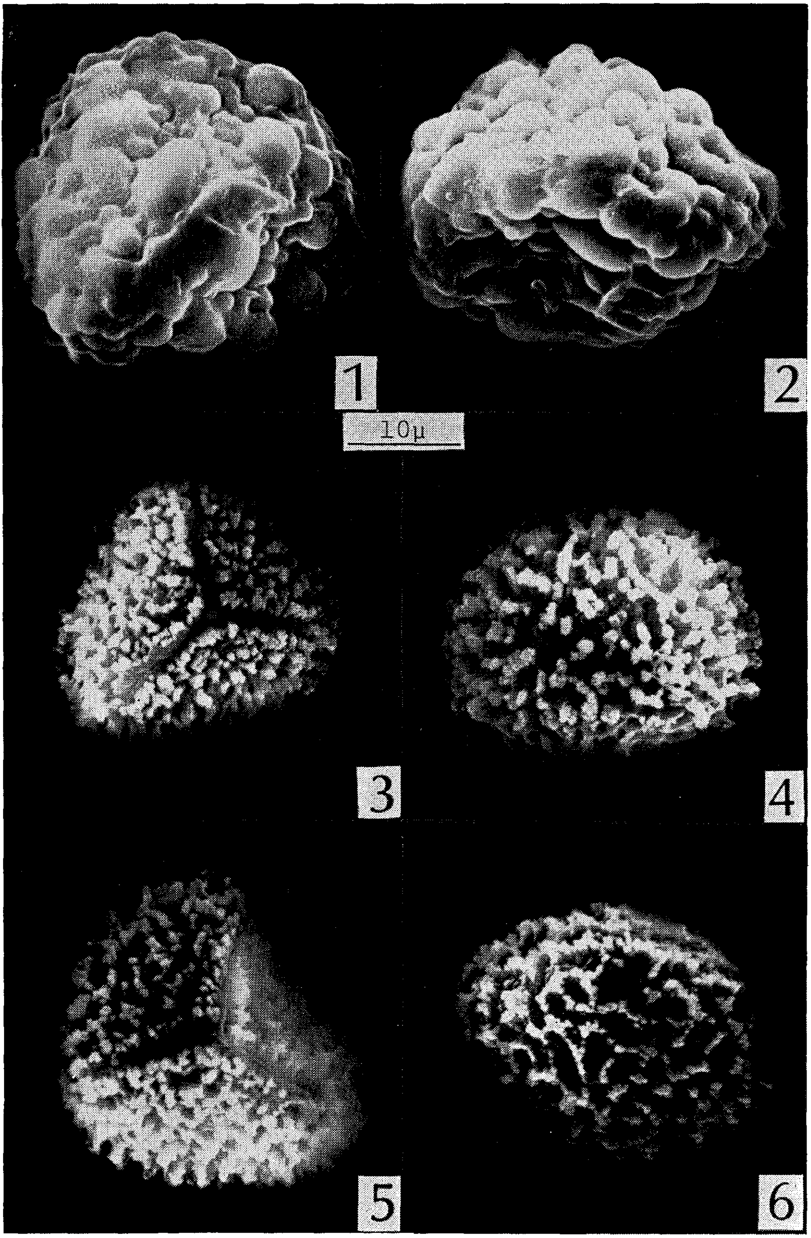
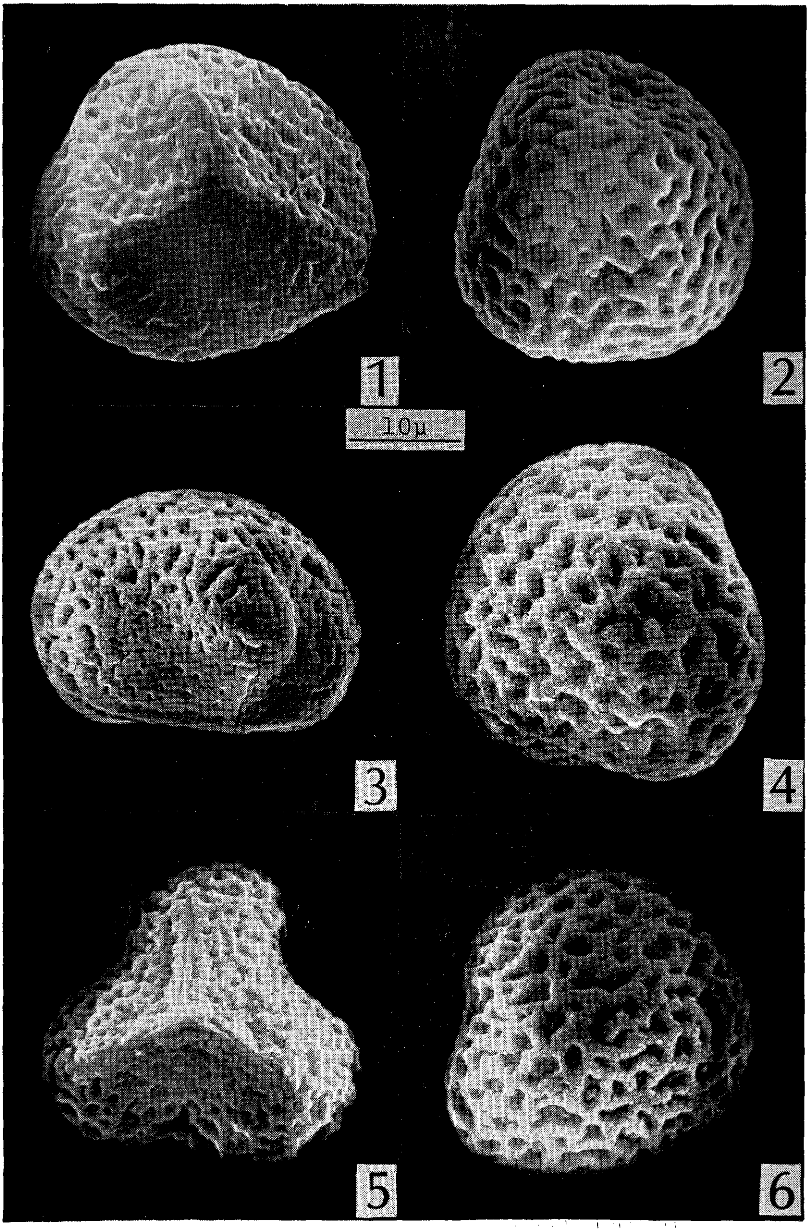
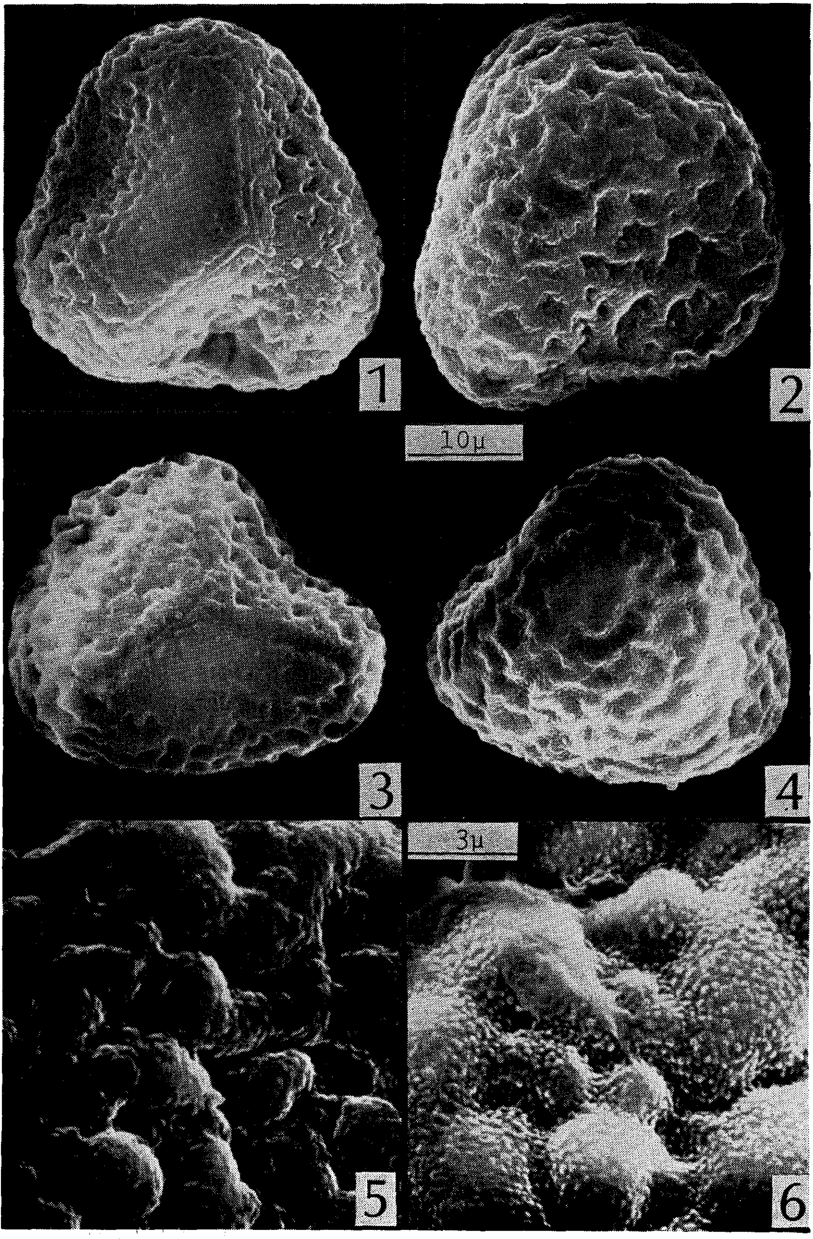
N. SAHASHI: Spore of Botrychiaceae



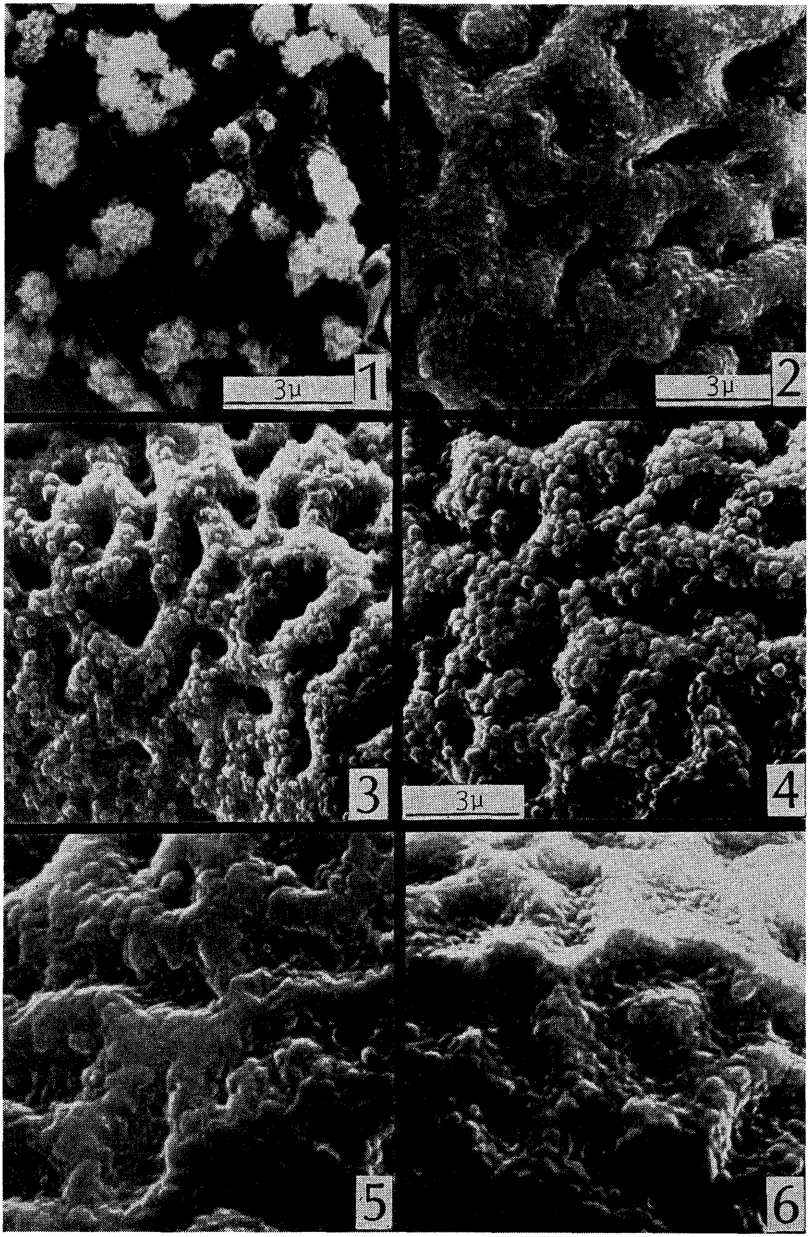
N. SAHASHI : Spore of Botrychiaceae



N. SAHASHI: Spore of Botrychiaceae



N. SAHASHI: Spore of Botrychiaceae



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